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(71) Applicant: **MITSUBISHI DENKI KABUSHIKI KAISHA**
Tokyo 100-8310 (JP)

(72) Inventors:
- **Yoshihara, Ikuhiro**
  Chiyoda-ku, Tokyo 1008310 (JP)
- **Kawakami, Kanehiro**
  Chiyoda-ku, Tokyo 1008310 (JP)
- **Hosogai, Setsuo**
  Chiyoda-ku, Tokyo 1008310 (JP)

(74) Representative: **HOFFMANN - EITLE**
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) Circuit breaker

(57) A circuit breaker in which a breaker case (1) is composed of a base (1a) and a cover (1b) and that is formed by accommodating one of unitized automatic tripping devices in a unit housing portion (28) of the base (1a). An electronic automatic tripping unit (32C), a thermal electromagnetic automatic tripping unit (32B), and an earth-leakage detection type automatic tripping unit (32A) have outer structures of the same shape from which a trip portion (32c), terminal conductors (32a), and movable-contact-side conductors (32b) are exposed. An overcurrent tripping element (33), a leakage detection ZCT (34), an amplification circuit (35) for amplifying an output of the leakage detection ZCT (34), and an earth-leakage tripping electromagnet portion (36) that operates on the basis of an output of the amplification circuit (35) are accommodated in the outer structure of the earth-leakage detection type automatic tripping unit (32A).

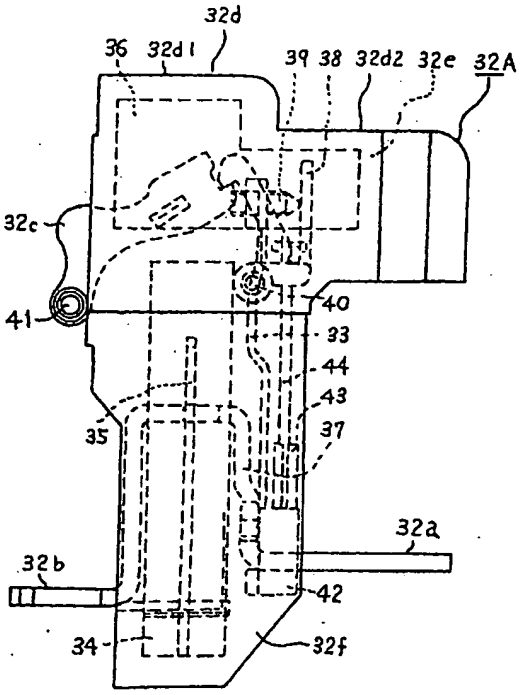

Fig. 3

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a circuit breaker having unitized automatic tripping devices.

2. Description of the Related Art

[0002] Among circuit breakers having unitized automatic tripping devices is one that is disclosed in Japanese Patent No. 2, 583, 491. In this circuit breaker, two types of automatic tripping devices, that is, an electronic one and a thermal electromagnetic one, are each unitized and have the same outer shape. A breaker case has a unit housing portion capable of housing each unit.

[0003] Only the electronic automatic tripping unit and the thermal electromagnetic one are prepared for the above circuit breaker so as to be replaceable. However, no earth-leakage detection type automatic tripping unit is available. Therefore, it is necessary to produce a separate circuit breaker having an earth-leakage tripping device. There is another problem that the above automatic tripping units having the same outer shape do not have a sufficient space to accommodate all the components of an earth-leakage tripping mechanism, that is, an overcurrent tripping element, a leakage detection ZCT, an amplification circuit, and an earth-leakage tripping electromagnet portion.

SUMMARY OF THE INVENTION

[0004] The present invention has been made to solve the above problems, and an object of the invention is therefore to provide a circuit breaker that makes it possible to substitute and replace also an earth-leakage detection type automatic tripping unit.

[0005] To attain the above obj ect, the invention provides a circuit breaker in which a breaker case is composed of a base and a cover and that is formed by accommodating one of unitized automatic tripping devices in a recess of the base, wherein an electronic automatic tripping unit, a thermal electromagnetic automatic tripping unit, and an earth-leakage detection type automatic tripping unit have outer structures of the same shape from which a trip portion, terminal conductors, and movable-contact-side conductors are exposed; and wherein overcurrent tripping elements, a leakage detection ZCT, an amplification circuit for amplifying an output of the leakage detection ZCT, and an earth-leakage tripping electromagnet portion that operates on the basis of an output of the amplification circuit are accommodated in the outer structure of the earth-leakage detection type automatic tripping unit.

[0006] In the circuit breaker according to the invention, the automatic tripping devices of the respective types are unitized into units having the same outer shape. Therefore, the automatic tripping devices of the respective types including the earth-leakage detection type automatic tripping device can be replaced with one of the other two types of the tripping devices. This provides an advantage that it is not necessary to produce a separate circuit breaker peculiar to an earth-leakage detection type automatic tripping device as in the conventional case; it is sufficient to produce a single type of circuit breaker.

[0007] The other objects and features of this invention will become understood from the following description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Fig. 1 is a top view of a circuit breaker according to a first embodiment of the present invention;
Fig. 2 is a somewhat enlarged sectional view taken along line II-II in Fig. 1;
Figs. 3-5 is a side view, a top view, and a perspective view, respectively, of an earth-leakage tripping unit according to the first embodiment;
Fig. 6 shows the internal structure of a an earth-leakage tripping mechanism according to the first embodiment;
Fig. 7 is a perspective view showing an arrangement of a leakage detection ZCT and primary conductors of the earth-leakage tripping unit according to the first embodiment;
Fig. 8 is a partially sectional view of an electromagnetic tripping portion of the earth-leakage tripping unit according to the first embodiment;
Fig. 9 shows an important part of a thermal electromagnetic tripping unit according to the first embodiment;
Fig. 10 shows an important part of an electronic tripping unit according to the first embodiment;
Fig. 11 is a side view of an earth-leakage tripping unit of a circuit breaker according to a second embodiment of the invention;
Fig. 12 shows an outer structure of the earth-leakage tripping unit according to the second embodiment; and
Fig. 13 illustrates a relationship between a leakage detection ZCT and amplification circuit in the earth-leakage tripping unit according to the second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1

[0009] A first embodiment of the present invention will be hereinafter described. Fig. 1 is a top view of a circuit

breaker according to the first embodiment of the invention, and shows a state that a tripping unit is removed. The positions of conductors that would proj ect from a tripping unit if the tripping unit were attached are indicated by broken lines.

[0010] As shown in Figs. 1 and 2, a breaker case 1 made of a synthetic resin is composed of a base 1a and a cover 1b. Fixed contacts 3 are fixed to power-source-side fixed conductors 2 that are fixed to the base 1a, respectively. Movable contacts 6 that are opposed to the fixed contacts3 and are to come into or go out of contact with the fixed contacts 3 are fixed to movable elements 7, respectively. The movable elements 7 are connected, via flexible conductors (shunts) 8, to connection conductors 9, respectively, to be connected to one of automatic tripping units 32A, 32B, and 32C. Each contact arm 10 is divided into two parts, that is, a first contact arm 10a that holds the movable elements 7 and is linked to an opening/closing mechanism (described later) and a second contact arm 10b that holds the movable elements 7 rotatably by means of a first pin 11.

[0011] The first contact arm 10a and the second contact arm 10b are rotatably supported by a support shaft 12 of the contact arm 10. A crossbar 13 connects the first contact arms 10a of the respective poles. The first contact arm 10a is formed with a guide hole 14 extending in the opening/closing direction. The second contact arm 10b is formed with a long hole 15 extending in a direction that crosses the guide hole 14. Provided between the first pin 11 and a second pin 16, a pulling spring 17 urges the second pin 16 that is engaged with both of the guide hole 14 and the long hole 15. Apressure spring 18 is providedbetween the movable element 7 and the second contact arm 10b.

[0012] A manipulation handle 19 of the breaker causes, via an opening/closing mechanism 20, the movable element 7 to perform an opening or closing action. The opening/closing mechanism 20 of the breaker is composed of a cradle 20a, a top link 20b, a bottom link 20c, etc. The cradle 20a rotates on a rotary shaft 21. The bottom link 20c is provided with a link pin 22 as a link to the first contact arm 10a. The breaker case 1 is provided with an arc extinction room 23 for extinguishing an arc.

[0013] The base 1a is provided with a unit housing portion 28 that is a recess for housing one of the tripping units 32A, 32B, and 32C. An indication surface 29 of the unit 32A, 32B, or 32C is exposed. A latch portion 30 that is engaged with the cradle 20a of the opening/closing mechanism 20 is manipulated by a push of a trip portion 32c of the unit 32A, 32B, or 32C. The earth-leakage detection type tripping unit 32A (see Fig. 3), the thermal electromagnetic tripping unit 32B (see Fig. 9), and the electronic tripping unit 32C (see Fig. 10) can be replaced with each other because their outer structures have the same shape.

[0014] If an overcurrent flows in a state that as shown in Fig. 2 the unit 32A, 32B, or 32C is fitted in the unit housing portion 28 of the breaker base 1a and is connected to the conductors 9 (ordinary use state), the unit 32A, 32B, or 32C operates to push the trip portion 32c, whereby the latch portion 30 is manipulated. The trip portion 32c is normally urged counterclockwise about a shaft 41 by a torsion spring 41a (see Figs. 3 and 6).

[0015] The earth-leakage tripping unit 32A shown in Fig. 3 is shaped in such a manner that terminal conductors 32a and shunt connection conductors 32b as fixing-side conductors and the trip portion 32c project from the outer structure of the unit (described later in detail). The thermal electromagnetic tripping unit 32B shown in Fig. 9 is shaped in such a manner that terminal conductors 32a and shunt connection conductors 32b as fixing-side conductors and the trip portion 32c project from the outer structure of the unit. The electronic tripping unit 32C shown in Fig. 10 is shaped in such a manner that terminal conductors 32a, shunt connection conductors 32b, and the trip portion 32c project from the outer structure of the unit. In the side views of Figs. 3, 9, and 10, the earth-leakage tripping unit 32A, the thermal electromagnetic tripping unit 32B, and the electronic tripping unit 32C have the same, hook-like outer shape.

[Earth-leakage tripping unit]

[0016] The outer structures of the tripping units 32A, 32B, and 32C will be described below with reference to Figs. 3-5 by taking the earth-leakage tripping unit 32A as an example. The earth-leakage tripping unit 32A is composed of a unit base 32f to be inserted into the unit housing portion 28 and a unit cover 32d that is disposed on the unit base 32f (see Fig. 3). The unit cover 32d is composed of an equal-width portion 32d1 having approximately the same width as the unit base 32f in the breaker longitudinal direction and a projected portion 32d2 projecting away from the breaking portion (see Fig. 5), and assumes a hook shape when viewed from the side. Therefore, when the unit 32A is inserted in the unit housing portion 28 and combined with the breaker main body, the projected portion 32d2 is located over the terminal conductors 32a.

[0017] To perform a bimetal tripping operation at the occurrence of an overcurrent, an electromagnetic tripping operation at the occurrence of an overcurrent, and a tripping operation with a leakage detection ZCT, the earth-leakage tripping unit 32A needs to be equipped with elements for performing these three operations.

[0018] As shown in Figs. 3 and 7, of the internal space of outer structure formed by the unit base 32f and the unit cover 32d of the earth-leakage tripping unit 32A, a leakage detection ZCT 34 is mainly provided in the internal space of the unit base 32f. The portions of the three-phase primary conductors 37 between the terminal conductors 32a and the shunt connection conductors 32b penetrate through the cavity of the leakage detection ZCT 34. The major surfaces (i.e., the end faces of a hollow cylinder) of the leakage detection ZCT 34 extend perpendicularly to the longitudinal direction of

the circuit breaker. An output conductor 34a of the leakage detection ZCT 34 that is connected to a circuit board of an amplification circuit 35 is led out sideways from the leakage detection ZCT 34.

[0019] Each primary conductor 37 consisting of the terminal conductor 32a, an intermediate conductor 37a, and the shunt connection conductor 32b may be a member that is formed by bending a single plate-like conductor. Alternatively, each primary conductor 37 may be formed by joining a plurality of plate-like conductors by welding, screwing, or the like. As for the term "shunt connection conductors," the opening/closing-mechanism-20-side conductors of the primary conductors 37 are called the shunt connection conductors 32b because the circuit breaker being described is of such a type as to use the shunts 8. In general, they are called "movable-contact-side conductors."

[0020] As shown in Figs. 3 and 7, of the internal space of outer structure formed by the unit base 32f and the unit cover 32d of the earth-leakage tripping unit 32A, a projected portion 39 as a top portion of a bimetal 33, a relay trip bar 38, and an electromagnet portion 36 are provided in most of the internal space of the unit cover 32d at a high density. The electromagnet portion 36 is disposed at the top end of the bimetal 33 and is composed of an electromagnet, a plunger, a control circuit, and a fixing plate to which they are attached. The electromagnet portion 36 usually has a long and narrow shape considering a plunger stroke. Further, the electromagnet portion 36 is required to have a large size because it needs to house a large coil to produce sufficient force to push the relay trip bar 38. Therefore, it is appropriate to accommodate part of the electromagnet portion 36 in the unit cover 32d having the projected portion.

[0021] As shown in Fig. 3, the circuit board of the amplification circuit 35 for amplifying an electric output signal from the leakage detection ZCT 34 is disposed beside the leakage detection ZCT 34 and is press-fit in and fixed to a rib that is provided on an inner surface of the unit base 32f. The inside surface of the circuit board extends parallel with part of the outside circumferential surface of the leakage detection ZCT 34. As described above, the electromagnet portion 36 that operates on the basis of an output signal of the amplification circuit 35 is provided inside the unit cover 32d. The control circuit and part of the fixing plate of the electromagnet portion 36 are provided in a space 32e.

[0022] As shown in Figs. 3, 6, and 8, an overcurrent tripping element, more specifically, the bimetal 33, is fixed to one of the primary conductors 37 by squeezing so as to extend approximately parallel with the end faces (i.e., major surfaces) of the leakage detection ZCT 34. A fine adjustment threaded portion is provided at the tip of the bimetal 33, and the proj ected portion 39 that is in contact with the relay trip bar 38 is screwed in the threaded portion. Each primary conductor 37, the unit base 32 f, a fixing plate 4 6 made of a non-magnetic metal (stainless steel, aluminum, an alloy thereof, or the like), and a bracket-shaped yoke 42 are fastened to each other by tightening a fixing screw 46b. An electromagnetic tripping portion is formed by the yoke 42, an armature 43, a spring 45, and the fixing plate 46.

[0023] The armature 43 is a lamination of a plurality of magnetic plates (iron plates) , and the armature 43 itself and its moving plane are approximately parallel with the major surfaces of the leakage detection ZCT 34. The armature 43 can rotate on a rotary shaft 43a (a bearing is provided on the fixing plate 46). Normally, the armature 43 is urged counterclockwise (in Fig. 8) on the rotary shaft 43a by the spring 45 that is stretched between a hooking stud 43c of the armature 43 and a hooking stud 46a of the fixing plate 46. The armature 43 abuts on a stopper 46c that is provided on the fixing plate 46, thereby its rotation is stopped.

[0024] A tip portion 43b of the armature 43 is connected to a tripping rod 44, which is fixed to the relay trip bar 38 by a fixing screw 38a (see Fig. 6). Since the armature 43 consists of a plurality of magnetic plates, each magnetic plate can be made thin and hole formation and punching on each magnetic plate are facilitated. As a result, the fixing hole of the rotary shaft 43a, the tip portion 43b, the hooking stud 43c, etc. can be formed easily.

[0025] If a bimetal 33, the tripping rod 44, or the plunger of the electromagnet portion 36 exerts force on the relay trip bar 38, the relay trip bar 38 is rotated clockwise in Fig. 6 and hence is disengaged from the trip portion 32c, whereby the trip portion 32c is rotated counterclockwise in Fig. 6. The relay trip bar 38 is rotationally supported on a pin 40 (in Fig. 3, the pin 40 looks as if to be rotationally supported by the unit cover 32d; this is because the unit cover 32d and the unit base 32f have an overlap that extends to below the projected portion 39). Normally, the relay trip bar 38 is urged counterclockwise (in Figs. 3 and 6) about the pin 40 by a torsion spring (not shown). Part of the relay trip bar 38 is in contact with a stopper (not shown) that is provided on the unit base 32f, whereby the relay trip bar 38 is held at the position of the figures.

[0026] Next, the tripping operation of the earth-leakage tripping unit will be described with reference to Figs. 3, 6, and 8. The tripping operations with overcurrent detection, that is, the tripping operation of the bimetal 33 and the electromagnetic tripping operation, will be described first, and then the tripping operation with leakage detection will be described. (Tripping by the bimetal at the occurrence of overcurrent)

[0027] If an overcurrent flows through a primary conductor 37, the bimetal 33 (see Fig. 6) is bent rightward and the projected portion 39 at the tip of the bimetal 33 pushes the relay trip bar 38, whereby the relay trip bar 38 is rotated clockwise (in Fig. 6) about the pin 40 and disengaged from the trip portion 32c. As a result, the trip portion 32c is rotated counterclockwise (in Fig. 6) about the shaft 41 which is the rotation supporting point of the trip portion 32c. The trip portion 32c pushes the latch portion 30 (see Fig. 2) and thereby trips the breaker

main body.

(Electromagnetic tripping at the occurrence of overcurrent)

[0028] If an overcurrent exceeds a certain limit (i.e., a current larger than a current that causes a tripping operation of the bimetal 33), the yoke 42 around the primary conductor 37 is magnetized and attracts the armature 43 so as to rotate the armature 43 clockwise (in Fig. 8) on the rotary shaft 43a. As a result, the tripping rod 44 connected to the armature 43 is moved downward (in Fig. 8) and the relay trip bar 38 is rotated clockwise (in Fig. 6) about the pin 40, whereby the breaker main body is tripped in the same manner as in the case of the tripping by the bimetal 33.

(Tripping by the leakage detection ZCT)

[0029] If a leakage occurs in a primary conductor 37 on the load side of the leakage detection ZCT 34 to cause a zero-phase-sequence current, the zero-phase-sequence current is picked up by the leakage detection ZCT 34 and amplified by the amplification circuit 35. As a result, the plunger of the earth-leakage tripping electromagnet portion 36 pushes the relay trip bar 38, whereby the breaker main body is tripped in the same manner as in the case of the overcurrent tripping operations.

[Thermal electromagnetic tripping unit]

[0030] Next, the thermal electromagnetic tripping unit 32B will be described. Referring to Fig. 9, attention is paid to each combination of a bimetal 50, a yoke 51, and an intermediate conductor 37b between a terminal conductor 32a and a shunt conductor 32b. The bimetal 50, the yoke 51, and the intermediate conductor 37b, all of which are provided in a unit base 32f, are squeezed into an integral member by means of rivets 52. The yoke 51 has a bracket-shaped cross-section and is disposed in such a manner that the opening of the bracket shape is located on the side opposite to the opening/closing mechanism 20 (i.e., on the side of an armature 53). Since the intermediate conductor 37b need not penetrate through a leakage detection ZCT, it is straight when viewed from above (i.e., in Fig. 1). The same is true of the electronic tripping unit 32C.

[0031] A relay trip bar 38 has an extended portion 38b that extends downward from a pin 40. In an electromagnetic tripping operation involving the armature 53, a yoke-confronting portion 53a of the armature 53 is attracted by the yoke 51 and the armature 51 is rotated counterclockwise on a rotary shaft 54. As a result, a tip portion 53b of the armature 53 touches the extended portion 38b of the relay trip bar 38, whereby the relay trip bar 38 is rotated clockwise about the pin 40. The circuit breaker is then tripped in the same manner as described above. The armature 53 is normally urged clockwise on the rotary shaft 54 by a spring (not shown). The tripping operation by bimetal 50 is the same as that by the bimetal 33 in the earth-leakage tripping unit 32A.

[Electronic tripping unit]

[0032] Next, the electronic tripping unit 32C will be described. As shown in Fig. 10, each intermediate conductor 37c that is located between a terminal conductor 32a and a shunt conductor 32b and provided in a unit base 32f is provided with a current detection CT 56. An output conductor 57 of the CT 56 is connected to an amplification circuit 58. An electromagnet portion 59 operates on the basis of an output of the amplification circuit 58. If an overcurrent occurs, the electromagnet portion 59 starts to operate, whereby a plunger 59a of the electromagnet portion 59 that has a trip portion 32c at one end is moved leftward andtouchesthelatchportion30 (see Fig. 2). Thecircuitbreaker is thus tripped.

[0033] Since, as described above, the earth-leakage tripping unit 32A, the thermal electromagnetic tripping unit 32B, and the electronic tripping unit 32C have the same outer shape (see Figs. 3, 9, and 10), each of the units 32A, 32B, and 32C can be accommodated in the unit housing portion 28 of the breaker case 1 in a replaceable manner as shown in Figs. 1 and 2.

[0034] Since the unit cover 32d2 has the extension space 32e that is located over the load-side terminal conductors 32a (see Figs. 2 and 3), the extension space 32c enables accommodation of the earth-leakage tripping electromagnet portion 36 as shown in Fig. 3.

[0035] The earth-leakage tripping electromagnet portion 36, which is conventionally provided on the opening/closing mechanism 20 side of the latch portion 30, is provided on the opposite side of the latch portion 30 to the opening/closing mechanism 20 and inside the outer structure of the tripping unit 32A. Therefore, the electromagnet portion 36 is not exposed to arc gas that may occur between the contacts 3 and 6 at the time of a break and hence is prevented from becoming non-operational after arc extinction.

[0036] The major surfaces of the leakage detection ZCT 34 are set perpendicular to the longitudinal direction of the circuit breaker and the bimetal 33 and the electromagnetic tripping portions (yokes 42 and armatures 43) are provided on the terminal conductor 32a side of the leakage detection ZCT 34. This prevents the electromagnetic tripping portions from being bombarded directly by an arc in the case where the opening/closing mechanism 20 side of the unit base 32f is open.

[0037] It is preferable that the primary conductors 37 be of a division type or have a small-cross-section portion for heating the bimetal 33 efficiently be provided at the position close to an end portion of the bimetal that are on the side of the case of the unit 32A or 32B opposed to the outside, because in this arrangement heat can easily be radiated outside the circuit breaker. In this

case, the metal fixing plates 46 for supporting the respective armatures 43 are located close to the respective bimetal 33. Therefore, the heat radiation is made more easier than in the case where the fixing plates 46 are made of a resin, and the armatures 43 can be fixed reliably while only a small space is occupied.

[0038] The major surfaces of the leakage detection ZCT 34 are set perpendicular to the longitudinal direction of the circuit breaker, and the major surface of the bimetal 33, the plane of the bracket shape of the yoke 42, themajor surfaces of the armature 43, and the moving plane of the armature 43 are set approximately parallel with the major surfaces of the leakage detection ZCT 34. This makes it possible to shorten the earth-leakage tripping unit 32A in the longitudinal direction of the circuit breaker.

Embodiment 2

[0039] A second embodiment of the invention will be hereinafter described.

[0040] Fig. 11 is a side view of an earth-leakage tripping unit of a circuit breaker according to the second embodiment of the invention. Fig. 12 is an explosion view of an outer structure of the earth-leakage tripping unit of Fig. 11. Fig. 13 illustrates a relationship between a leakage detection ZCT and amplification circuit in the earth-leakage tripping unit of Fig. 11. To facilitate understanding, a bimetal and electromagnetic tripping portions are not shown in Fig. 13. The other part of the configuration is the same as in the first embodiment and hence will be omitted.

[0041] As shown in Figs. 11 and 12, the unit base 32f is divided, in the longitudinal direction of the circuit breaker, into two parts, that is, an opening/closing-mechanism-side base 32f1 and a terminal-side base 32f2. To assemble the earth-leakage tripping unit 32A, the primary conductors 37, the bimetal 33, the electromagnetic tripping portions (yokes 42, armatures 43, etc.), the leakage detection ZCT 34, the amplification circuit 35, the electromagnet portion 36, the relay trip bar 38, etc. are attached to the terminal-side base 32f2. Then, the opening/closing-mechanism-side base 32f1 is fixed to the terminal-side base 32f2 with screws (not shown), and the unit cover 32d is fixed to the unit base 32f.

[0042] In the second embodiment, the amplification circuit 35 is disposed beside the leakage detection ZCT 34 in such a manner that its inside surface extends parallel with part of the outside circumferential surface of the leakage detection ZCT 34. Where each of the primary conductors 37 is of a monolithic type, they are attached to the load-side base 32f2 being brought downward (in Fig. 13) together with the leakage detection ZCT 34. Where each of the primary conductors 37 is of a division type, first the leakage detection ZCT 34 is attached to the load-side base 32f2 and then the amplification circuit 35 is brought from the viewer's side toward the deep side (in Fig. 13).

[0043] As described above, since the outer structure of the earth-leakage tripping unit 32A is composed of three members, the amplification circuit 35 can be accommodated in such a manner that its inside periphery extends along part of the outer circumference of the leakage detection ZCT 34. Further, dense mounting is enabled and the airtightness of the outer structure can be increased.

Claims

1. A circuit breaker in which a breaker case (1) is composed of a base (1a) and a cover (1b) and that is formed by accommodating one of unitized automatic tripping devices (32A,32B and 32C) in a unit housing portion (28) of the base (1a), wherein;

   the automatic tripping devices include an electronic automatic tripping unit (32C), a thermal electromagnetic automatic tripping unit (32B), and an earth-leakage detection type automatic tripping unit (32A) having outer structures of the same shape from which a trip portion (32c), terminal conductors (32a), andmovable-contact-side conductors (32b) are exposed; and

   an overcurrent tripping element (33) , a leakage detection ZCT (34), an amplification circuit (35) for amplifying an output of the leakage detection ZCT (34), and an earth-leakage tripping electromagnetportion (36) thatoperatesonthebasisofanoutput of the amplification circuit (35) are accommodated in the outer structure of the earth-leakage detection type automatic tripping unit (32A).

2. The circuit breaker according to claim 1, wherein the outer structure of each of the automatic tripping units (32A, 32B and 32C) is formed by a unit base (32f) and a unit cover (32d) that are a bottom portion and a top portion of the outer structure, respectively, and the unit cover (32d) projects from the unit base (32f) so as to be located over portions of the terminal conductors (32a) that are exposed from the unit base (32f).

3. The circuit breaker according to claim 1, wherein the outer structure of each of the automatic tripping units (32A, 32B and 32C) is formed by a unit base (32f) that is to be inserted in the unit housing portion (28) of the base (1a) and a unit cover (32d) that is located above the unit base (32f) and projects from the unit base (32f) in such a direction as to go away from an opening/closing mechanism of the circuit breaker; and in the earth-leakage detection type automatic tripping unit (32A), a projected portion of the unit cover (32d) houses part of the earth-leakage tripping electromagnet portion (36).

4. The circuit breaker according to claim 1, wherein in the outer structure of the earth-leakage detection type automatic tripping unit (32A), the leakage detection ZCT (34) is disposed on a side closer to an opening/closing mechanism of the circuit breaker and overcurrent tripping portions are disposed on an opposite side of the leakage detection ZCT (34) to the opening/closing mechanism.

5. The circuit breaker according to claim 1, wherein in the outer structure of the earth-leakage detection type automatic tripping unit (32A), the leakage detection ZCT (34) is disposed in such a manner that its major surfaces are perpendicular to a longitudinal direction of the terminal conductors (32a), overcurrent tripping bimetal (33) are disposed in such a manner as to extend parallel with the major surfaces of the leakage detection ZCT (34) in a depth direction of the unit housing portion (28), and a yokes (42) of electromagnetic tripping portions and a moving plane of an armature (43) to be attracted by the respective yoke (42) are disposed parallel with the major surfaces of the leakage detection ZCT (34).

6. The circuit breaker according to claim 5, wherein a fixing plate (46) made of a non-magnetic metal by or to which the armature (43) or the yoke (42) of the electromagnetic tripping portions is supported or fixed, respectively, is opposed to an outer surface of the outer structure.

7. The circuit breaker according to claim 1, wherein the outer structure of each of the automatic tripping units (32A, 32B and 32C) is formed by a unit base (32f) that is to be inserted in the unit housing portion (28) of the base (1a) and a unit cover (32d) that is located above the unit base (32f), and the unit base (32f) is formed by combining an opening/closing-mechanism-side unit base (32f1) that is closer to an opening/closing mechanism of the circuit breaker and a terminal-side unit base (32f2) that is farther from the opening/closing mechanism.

8. The circuit breaker according to claim 7, wherein the amplification circuit is formed on a circuit board and the circuit board is provided so as to extend along part of an outside circumference of the leakage detection ZCT (34) in a plane parallel with major surfaces of the leakage detection ZCT (34).

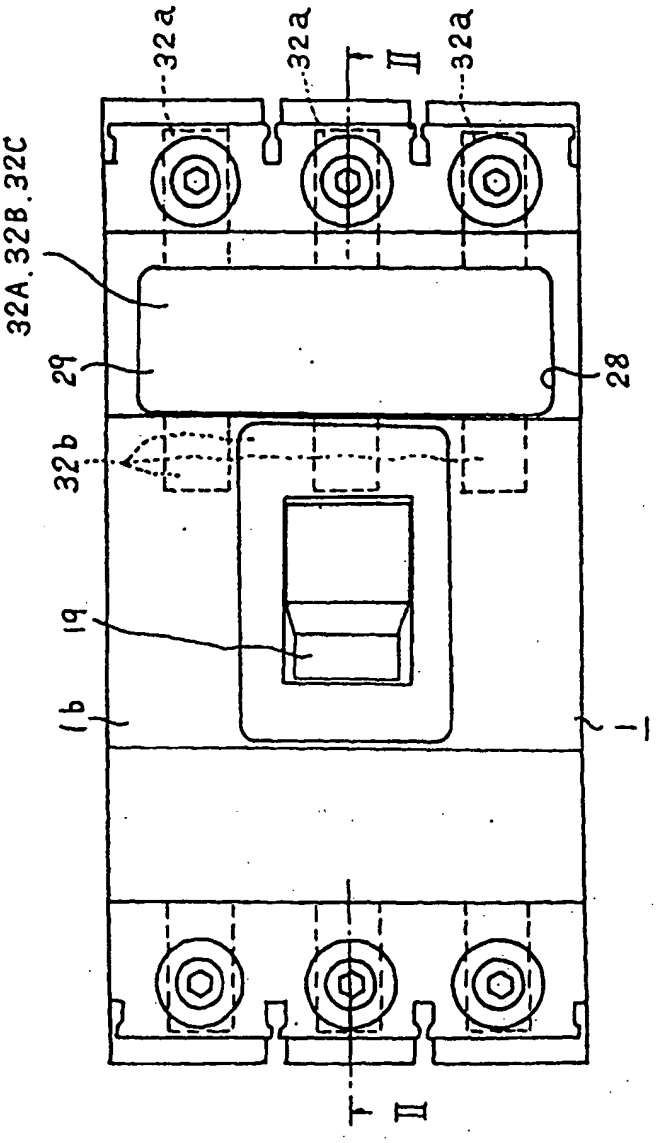
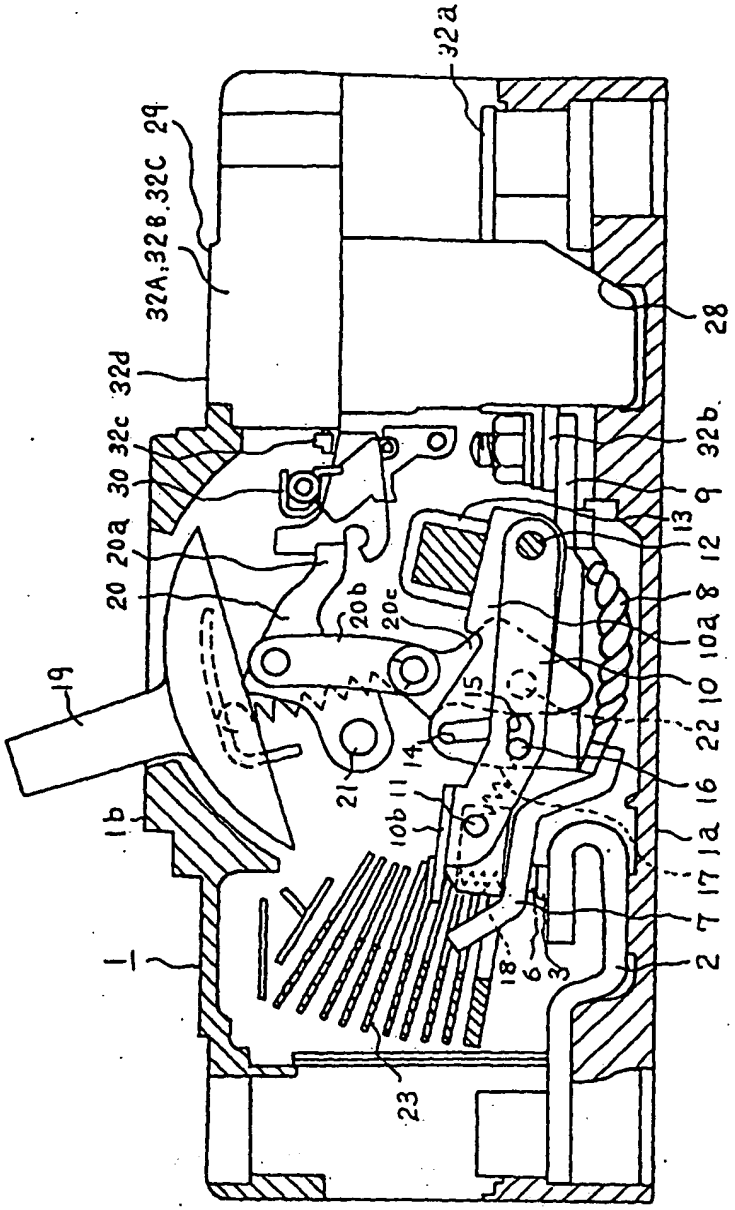


Fig. 1


32a
29
32A,32B,32C
28
32d
32c
32b
30
9
20
20a
13
12
20b
20c
8
10a
19
15
10
22
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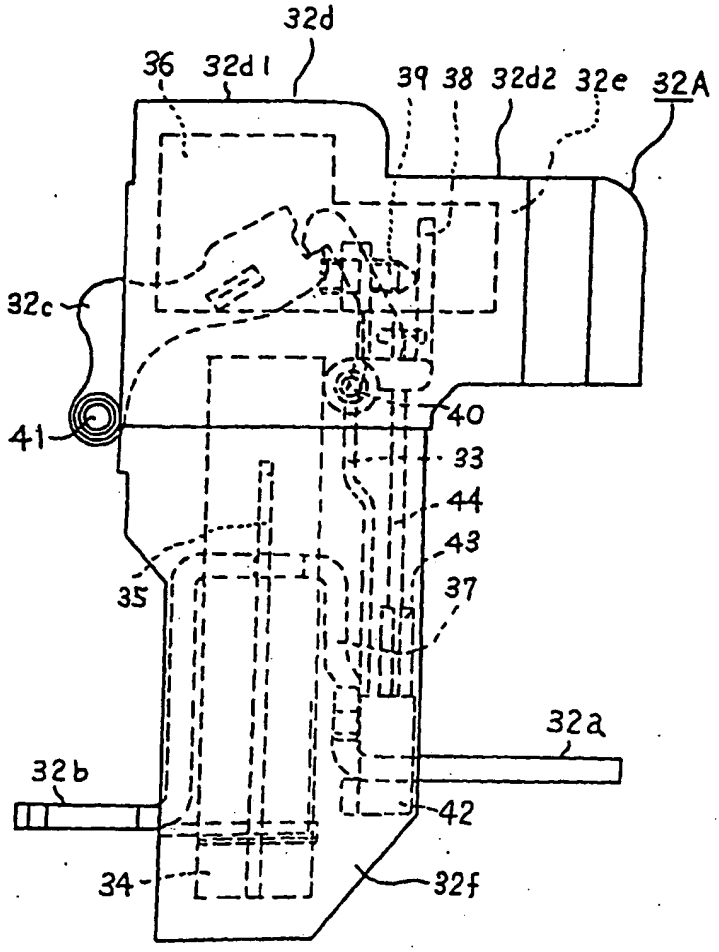
16
21
11
10b
1b
17
1a
7
2
18
6
3
1
23

Fig. 2


32d
36
32d1
39
38
32d2
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32A
32c
41
40
33
44
43
37
35
32a
32b
42
34
32f

Fig. 3

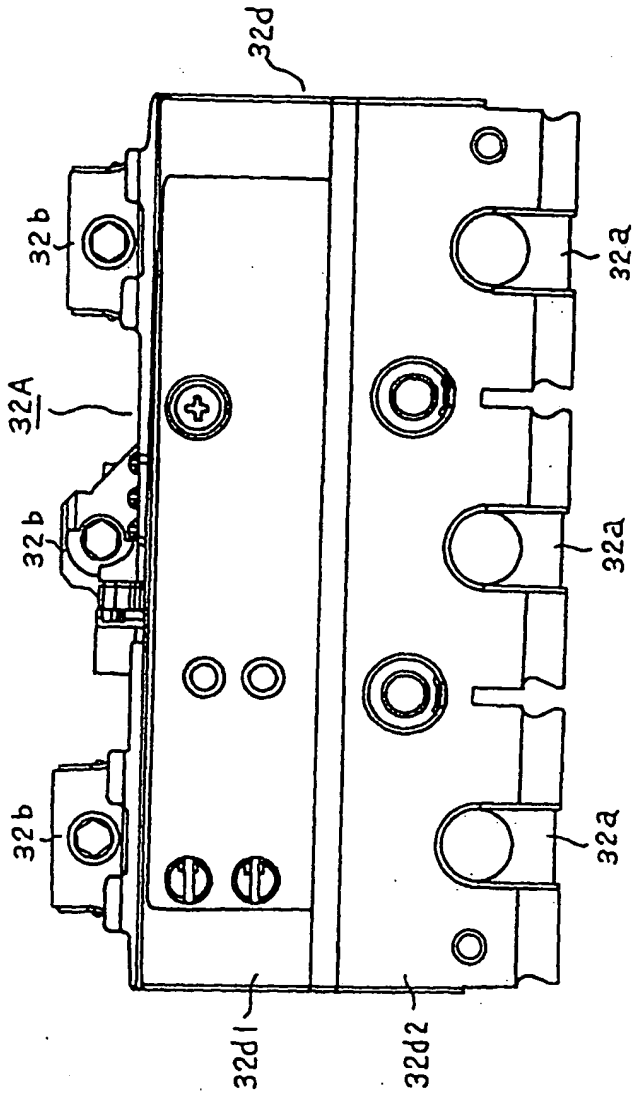

Fig. 4

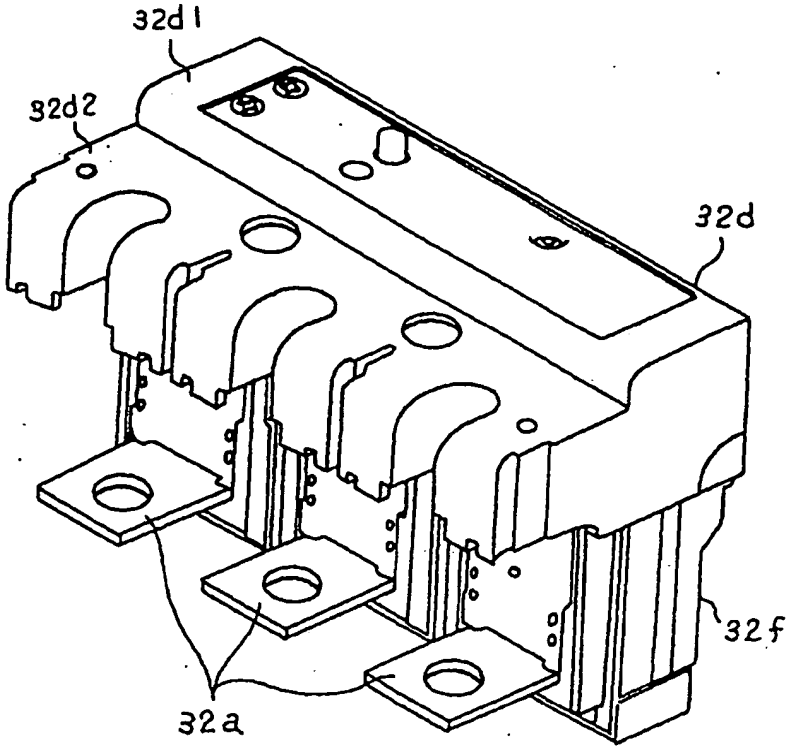

Fig. 5

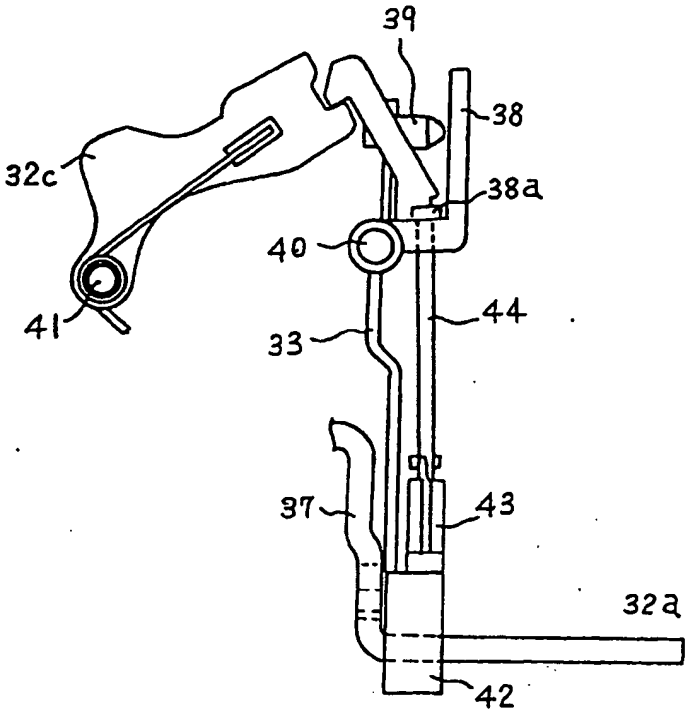

Fig. 6

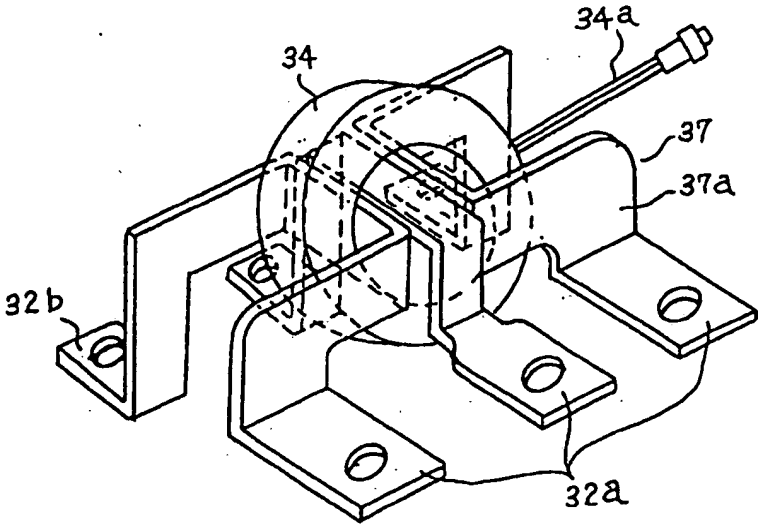

Fig. 7

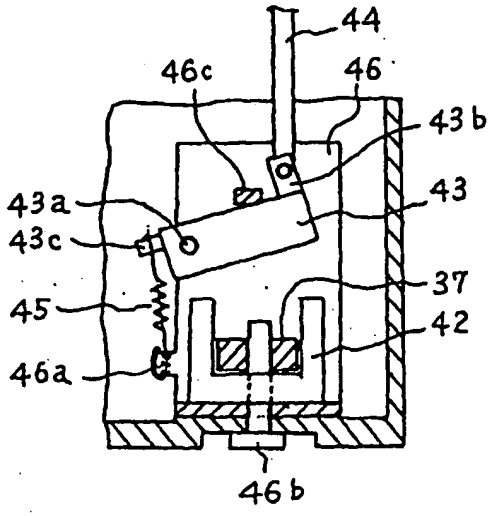

Fig. 8

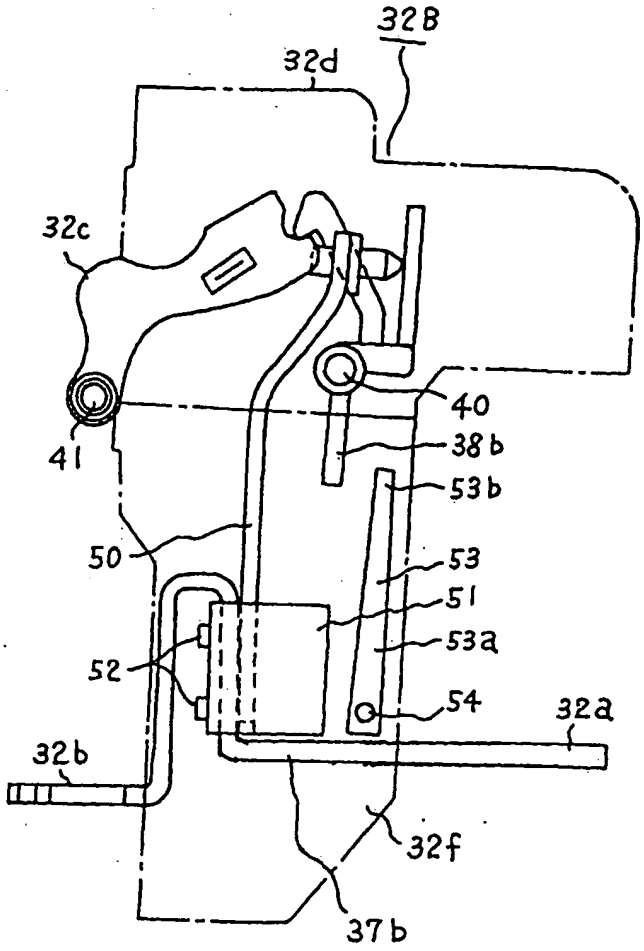

Fig. 9

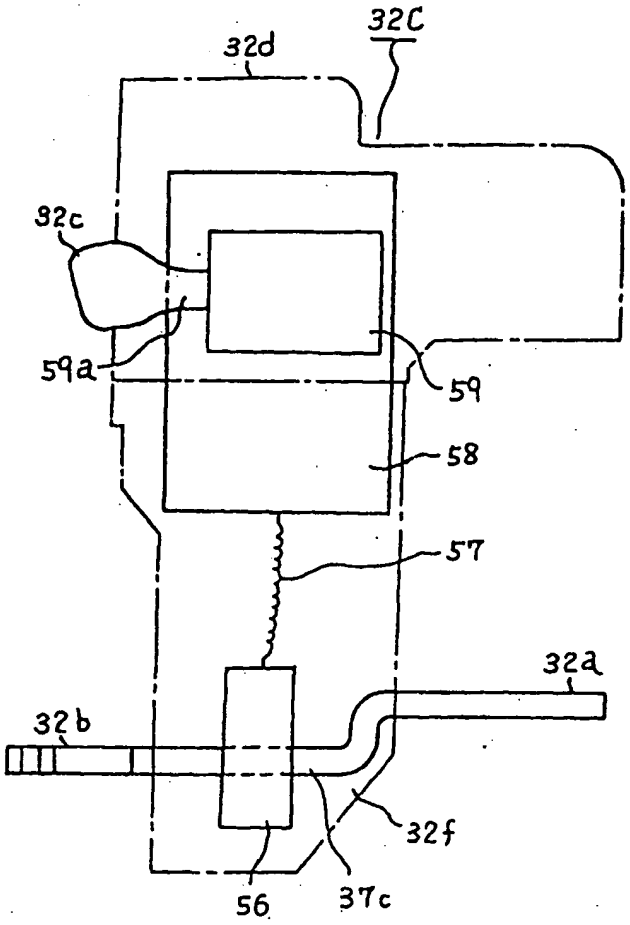

Fig. 10

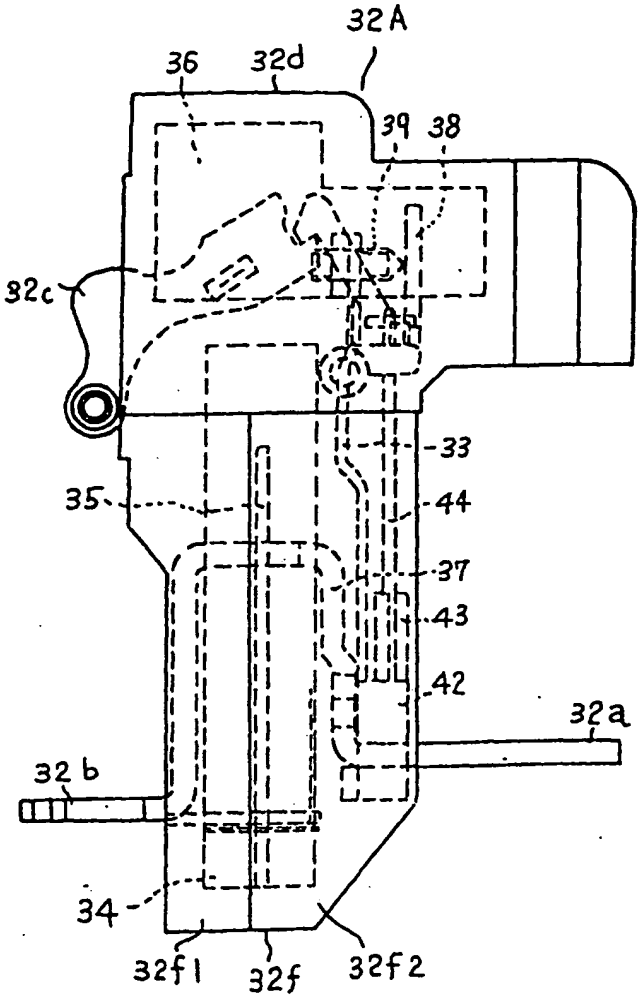

Fig. 11

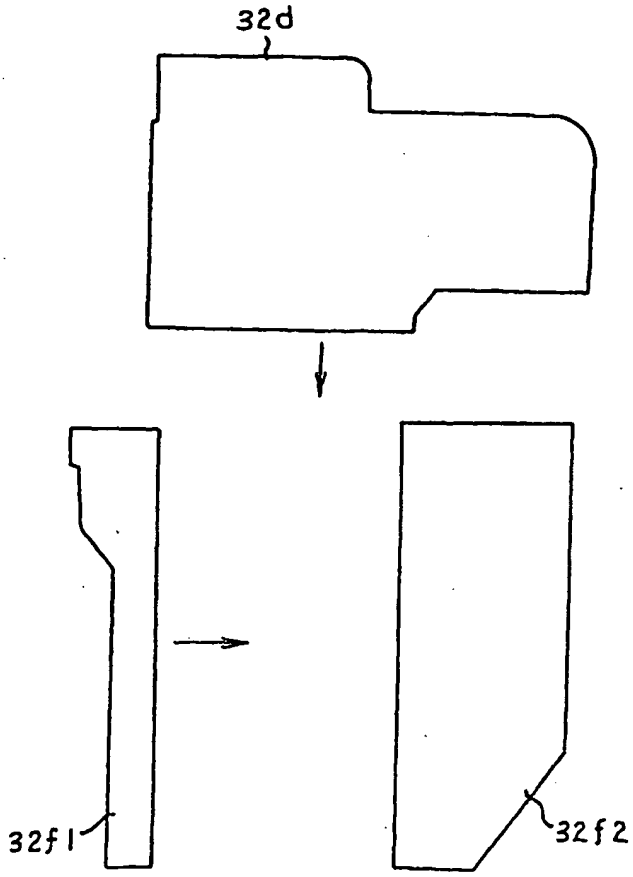

Fig. 12

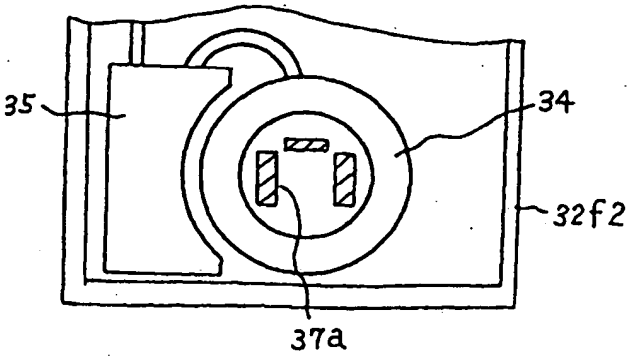

Fig. 13

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Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	16 February 2004	Mäki-Mantila, M

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